looked for is a fact more interesting than the contrast influence itself. The knowledge that one might be expected to find a color unusually agreeable if one had just seen a very disagreeable color, or *vice versa,* instead of aiding the natural contrast influence by the force of positive suggestion, seems merely to have confused and obliterated it. Whether this was because the observers resisted the suggestion we cannot say, without introspective data which could not in the nature of the case have been furnished. Suggestion does have a positive influence on the pleasantness and unpleasantness of colors, even when it is given in the form of direct verbal suggestion, which is most apt to stir up opposition. It seems, however, that affective reactions are so delicately adjusted that we cannot merely add one positive influence to another and look for a summation of effects. The factor of affective contrast is most strongly operative when the affective judgments are made on the bare sense impressions, without any extraneous influence.

XXVI. The Correlation Between Accuracy of the Visual Memory After-Image and Control of Visual Imagery

By Helen Adler, Myra Williams, and M. F. Washburn

We have long outgrown the idea that individuals can be classed simply as belonging to the auditory-motor, visual, mixed, *etc.* types, as regards their mental imagery. We know that a person may habitually make use of one kind of imagery, and yet be capable of extremely vivid imagery of another kind under certain circumstances: that is, we realize that the frequency with which a certain modality of imagery is used is not necessarily correlated with the intensity which it is capable of reaching in the mind of the same observer. In the same way, intensity and accuracy of imagery are not necessarily connected. An individual characteristic of great practical importance is the power to control visual imagery. Anyone who has to *think* in terms of visual space, the geometrician, the astronomer, the engineer, needs the power of shifting the parts of his visual images and making them take up new relations to each other, of moving them about in his mind without distorting the spatial relations which the actual objects would maintain if they were physically moved about. How far does ability to control visual imagery correlate itself with other characters such as frequency, intensity, and accuracy of visual imagery?

The present study attempts to study the correlation between ability to control the spatial relations of the parts of a visual image, with ability to reproduce accurately a complex visual image just seen. We shall refer to these characters briefly as 'control' and 'accuracy;' of course they are very special kinds of control and accuracy. Our measure of accuracy was obtained in the following way. We prepared a set of ten cards 8 cm. square. Each card was divided by ruled lines into four equal compartments, and in each compartment a different 'nonsense figure' of eight straight lines was drawn with red ink. Each of these cards was laid in turn on the table before the observer, who sat with closed eyes, and at a signal she opened her eyes and looked at the card for ten seconds. The card was then removed and the observer drew on a blank diagram as much as she could remember of the figures on the card. The same procedure was followed with the other nine cards. The problem of satisfactorily evaluating the results in terms of accuracy is not an easy one.

We proceeded on the general plan followed in Binet's letter-square method. We gave to a line correct in direction and in the right place on its design the value 1, and a line that was correct in direction but misplaced we counted as ½. A line added that was not on the design deducted ¼ from the total. An observer's total percentage of accuracy was found by adding together her 'marks' for all ten cards and dividing the sum by 320, the total number of lines on the ten cards. Of course a certain amount of liberty of judgment had to be allowed in estimating the value of a reproduction; in distinguishing, for instance, between a misplaced and an added line. The results of about half the observers were evaluated by one of the experimenters and those of the other half by the other experimenter: two separate estimates were made of all the results by the third author of the paper, and the evaluations were thus at least approximately uniform for the different observers.

Each observer whose accuracy in the immediate reproduction of a visual nonsense figure was thus measured was given, between every two accuracy tests, a test of the power to control the spatial relations of the parts of an image.

The plan of the control tests was the following. A square diagram of 3.5 cm. a side was drawn and divided by lines into sixteen equal compartments. In the uppermost and extreme left-hand compartment a small equilateral triangle was drawn. The observer looked at this diagram for five seconds; she then closed her eyes, and in pursuance of directions previously given, followed the experimenter's command to imagine the triangle moved to another square of the diagram. The experimenter directed ten such imaginary movements of the triangle, the movement to start each time from the position which the triangle occupied as the result of the last imagined movement. As the observer imagined a movement to be carried out, she signalled the fact to the experimenter, who then directed the next movement. When the ten movements had been imagined, the observer opened her eyes and indicated on what square of a blank diagram like the original the triangle would be placed as a result of the ten successive movements. A stop-watch had been started by the experimenter as she directed the first movement, and was stopped as soon as the observer reported that the last movement had been carried out. Ten such experiments were made with each observer, alternating with the ten accuracy tests. A different sequence of imaginary movements was of course required in each control test. The following sample series may serve as an illustration: "One square obliquely down and to right, two to right, two down, one to left, three up, one obliquely down to left, one to left, two down, two obliquely up to right, one to right;" "Two to right, one obliquely down to right, two obliquely down to left, two up, one to left, two obliquely down to right, one to right, two to left, one obliquely up to right, two up."

As measures of ability to control the image, there were thus available the total number of errors made in the final placing of the triangle in the ten experiments, and the average time required for carrying out the ten movements in a single experiment. Of course it might happen that a correct final placing of the triangle would result from a series of movements in which several errors were made that compensated for each other. The chances of this were not very great, however. The order of the observers as regards control was determined by multiplying the number of errors by the average time required. This value of course was inversely proportional to

the degree of control. The few observers who made no errors in the ten control tests were put at the top of the list in the inverse order of their average times.

A comparison of the list of observers (forty-three in number, all young women) arranged in the order of the accuracy with which they reproduced the nonsense figures and a list arranged in the order of excellence of control reveals a complete absence of correlation between these two performances. The Pearson coefficient is +.073. The average per cent. of accuracy is 46.4, with a maximum of 66 and a minimum of 28. The average coefficient of control (number of errors multiplied by time in seconds) is 124.5, with a maximum of 286.2 and a minimum of 16.7. The observers fell into groups as follows. If they were divided as regards both accuracy and control into an upper division of fourteen, a lower division of fourteen, and a middle division of fifteen, the observers forming the largest group (eight) as regards correlation were those of moderate accuracy and moderate control. There were six who had high accuracy and high control, six who had low accuracy and low control, and six who had high accuracy and low control. There were only three who had low accuracy and high control. On the other hand there were five who had low accuracy and moderately good control. There were also five who had moderate accuracy and high control; two who had high accuracy and moderate control, and two who had low control and moderate accuracy. On the whole, then, it would appear that a person may be able to reproduce a nonsense figure in immediate memory with considerable accuracy, and yet be unable to move an imaginary triangle around a sixteen square diagram in ten successive positions without losing memory of the correct spatial relations, while on the other hand an observer may be very successful in the movement test and very poor at reproducing the nonsense figures. This latter possibility the originator of the problem (M. F. W.) confirms from her own general experience. She is a very poor visualizer, measured by the accuracy or vividness with which she can recall images of things seen, yet she has always been able to think clearly in spatial relations, and as an undergraduate had a special liking for geometry and trigonometry. There is a type of visual image, into which much kinaesthesis enters, which is stripped of color and details of form and represents spatial relations purely; these are all the clearer for the general bareness of the image. The psychology of this type of image deserves further investigation.